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Research Article

Mapping urban expansion and its effect on the surrounding land uses using GIS and remote sensing. A case study in Debre Tabor Town, Ethiopia

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Abstract: In recent years, GIS and Remote Sensing technology has played a vital role in studying urban growth and development. This study is aimed to assess the effects of urban expansion on the surrounding land uses using GIS and Remote Sensing in Debre Tabor Town. Remote sensing data or products such as Aerial photograph (1984), Quick Bird Satellite Image (2000), and Aerial photograph (2016) were used to compute spatial or temporal changes of land use land cover due to urban expansion. ERDAS Imagine and Arc GIS software were used to analyze, model and map the data. The study revealed a significant change in urban boundary and urban land-use land cover between 1984 and 2016. The urban boundary expansion rate between the years 1984 and 2000 was 69.06%, higher than the rate experienced thereafter to the year 2016 (18.86%). However, for the last thirty-two years, between 1984 and 2016, the overall boundary increasement of almost eighty one percent (81.4) was very magnificent. The study also indicated that the area experiencing rapid increase in built-up areas (80.93 %), and agricultural land (23.81%). However, sharp decrease of forest by 36.07%, and open land by 65.02% was seen in the same periods of years. Built-up area expansion was found to have increased by expanding the urban boundary at the expense of open land, agricultural land, and forests. Therefore, integrating GIS and remote sensing technology for urban expansion mapping is a worthy method. Hence, it is recommended that it will be cost effective if the results of this study will be incorporated into ongoing urban planning and land use by concerned bodies.

Keywords*: effect, land cover, land use change, mapping, urban expansion*

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Introduction

Humans have been using land and its resources for centuries in a pursuit of their better lives. The way humans have used land and exploited its resources related to urbanization, agriculture, and other demands (Cieslewicz, 2002). The process of urbanization is a common phenomenon taking place all over the world, where human being lives, and such process happen due to the increase in population growth, economy and infrastructure initiatives in a particular area (Kombe and Kreibich, 2000). Urbanization is growing in both developed and developing countries. Between 2000 and 2030, the world's urban population is expected to increase by 72%, while the built-up areas of cities of 100,000 people or more could increase by 175%. The space taken up by urban areas is increasing faster than the urban population itself (Angel et al., 2005). However, urbanization in the developing world in general is progressing much faster than in developed countries, which may reach 3% or even 4% a year (Soubbotina, 2004). The fast rate of urbanization in developing world is attributed to rural–urban migration, economic growth and development,

technological change, and rapid population growth (Marshall et al., 2009). Even though the least developed in the world, Sub-Saharan Africa has been experiencing the highest population growth rate of 4.7%, rural-urban migration being the key driver (Tevera and Zamberia, 2010). Many a times, the positive aspects of urbanization are overshadowed by deterioration in the physical environment and quality of life caused by the widening gaps between supply and demand for essential services and infrastructure. Urban expansion has significant implications for resource extraction and use, waste generation, and land transformation through built footprint expansion and changed LULC patterns (Van der Linden and Hostert, 2009). Rapid urbanization, as highlighted by Bhagawat (2011), has therefore brought about serious losses of arable land, forest land and water bodies. Ultimately, it places an increasing demand on not just the land, but even on housing, services and infrastructure (Tevera and Zamberia, 2010). Such has led to LULC being a major concern of global environment change. It raises questions about urban areas' current and future ecological sustainability, and the types of interventions that may be required to move it towards greater sustainability (Gasson, 2002). Verma et al. (2008) and Mengistu (2008) argued that urbanization becomes inevitable when pressure on land is high, agriculture incomes are low and population growth rate is high, a common scenario in developing countries.

Ethiopia is one of the least urbanized countries in the world. It has only 16% of its population living in urban centers (PCC, 2008). However, given the 2.73% total annual population growth rate, high rate of in-migration to towns, and increase in the number of urban centers, the rate of urbanization is increasing at a rate of 4.4% (MoFED, 2006). Rapid population growth and the low economic standard of living in the country have brought numerous consequences to land cover and use and other resources on the environment (Amare Sewnet, 2012). However, most studies of LULC changes in Ethiopia, as is the case elsewhere, have focused on the relationship between population growth, land management, land degradation, deforestation and the expansion of cultivation as well as the associated consequences (Tekle and Hedlund, 2000; Taddese, 2001; Mengistu, 2008; Amare Sewnet, 2012).

Moreover, in most developing countries; including Ethiopia, information on these changes is either lacking or unavailable, especially at town or city level. This leads to difficulty in generalizing as doing so could lead to erroneous conclusions (Mengistu, 2008). As referred to, data shortage compromises the planning and monitoring exercise. Primitive approaches such as actual ground surveys that have been used for planning and monitoring lacked the spatio-temporal factor (Lucas et al., 2007). It was in light of such limitations on such approaches that technological advancement birth GIS and Remote Sensing (RS). This is a technology that boasts of a strong capacity in data integration, analysis and visualization (Kraak and Ormeling, 2003). Trung et al. (2007) acknowledge that nowadays GIS and RS has become the main tool in land use planning. Its main advantage is its ability to perform multi-disciplinary and complex analysis both in time and space. This attribute makes it important for the monitoring, modelling and mapping of LULC changes across a range of spatial and temporal scales, in order to assess the extent, direction, causes, and effects of the changes (Mengistu, 2008). Hence, information on LULC changes, especially within the urban boundary, is essential for the selection, planning and implementation of land use schemes to sustainably meet the increasing demands for basic human needs and welfare (Baboo and Devi, 2010).

Therefore, this study tried to analyze the expansion of Debre Tabor town using remote sensing and GIS techniques for the last 32 years from 1984 up to 2016. The specific objectives that study addressed were therefore: (1) to map and analyses the expansion of Urban boundary from 1984 up to 2016, (2) to examine the effect of growing urbanization on the surrounding land-use and land-cover of Debre Tabor town, (3) to determine the future expansion of Debre Tabor town.

Materials and Methods

Study area

Debre Tabor town is located in the South Gondar Zone of the Amhara Regional State, and it far 672 km and 97 km in the north direction away from the national capital, Addis Ababa, and regional capital, Bahir Dar, respectively. The town has geographical extent of 11°51'N to 11° 52' 30''N latitude and 37° 59'E to 38° 02'E longitude (IDCSO, 2014).

Methods of data collection

The main data sources for the study were primary and secondary sources. The primary data were collected from interviews with Land Provision and Administration Head and focus group discussion with elder people who have been living in the town since 1978. A total of 15 residents,

five for each sub-city were involved in focus group discussion as key informants about the historical development of the town and other related socioeconomic consequences, as well as about the factors that contributed to urban expansion. The informants were selected considering into account the following criteria: age (elderly community members of 50 years older and above), willingness to provide information, continually resided in the area for the last 25 years and considered by the locals to be knowledgeable enough about the urban expansion and its impacts. Moreover, two officials from Debre Tabor Town Service (a Land Provision and Administration Heads). In addition, GPS readings, as firsthand information, also taken in the field to verify built up areas and to digitize kebeles' boundaries of the study area.

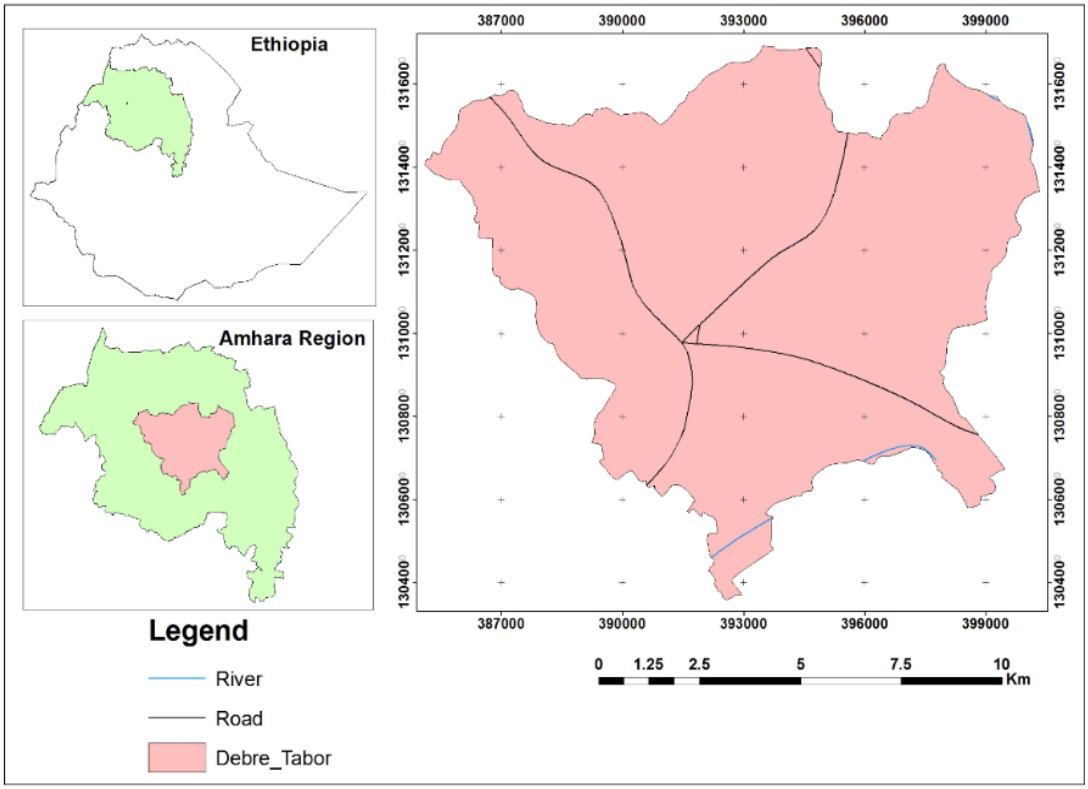


Figure 1. Map of Debre Tabor Town (Source: Ethio-GIS, 2016)

Population data, Topographic Map of Debre Tabor (1984) with scale of 1:50,000, Aerial photograph (1984) with scale 1:50,000, Quick Bird Satellite Image (2000), and Aerial photograph (2016) with scale 1:50,000 were the main secondary data type used in the study. The availability of Topo map, Aerial photo and Quick bird image dictated the choice of the respective study periods.

Different year's population data for the year 1984, 1994, and 2007 of the study area was obtained from national censuses results from Central Statistics Agency. Furthermore, the Topographic map, Quick Bird Satellite Image, and Aerial photograph were acquired from Ethiopian Mapping Agency. Primary data was used as a supportive evidence with secondary data during data analysis and interpretation.

Methods of data analysis

Urban expansion assessment

Rectification of aerial photographs was supported with Toposheet (1984). A minimum of four spatially distributed ground control points (GCPs) for each piece of aerial photographs, taking references such as churches, main road junctions and some other physical features were selected and located based on a geometrically corrected Toposheet (1984) of Debre Tabor as a reference aerial photograph. The error accepted was limited to 10 m or less.

ERDAS IMAGINE 10 software was used for image enhancement and image processing purpose so as to have clear image view of the study area before image digitization. Arc GIS package was employed to mask the boundary of the study area, to mask AOI from the input

datasets, and further to delineate, analyses and map urban expansion in various periods.

Geodatabase was created in Arc Catalogue before digitizing datasets and feature classes like built up areas, roads and LULC from Aerial photograph (1984), Quick Bird Satellite Image (2000), and Aerial photograph (2016). Furthermore, topology was developed on feature dataset to keep data integrity and connectivity well. Accordingly, each Toposheet and Aerial Photo were scanned, and then the digital images were orthorectified and registered in local coordinate system and map projection (UTM projection, Clarke 1880 spheroid, Adindan (datum), Zone 37 N) in Arc GIS 10.3.

The three years (1984, 2000, and 2016) expansion in both extent and direction of urban boundary in Debre Tabor Town was assessed by digitizing its administrative boundary in Arc GIS (See Figure 3). In addition, different LULC and features within the boundary were digitized using on-screen digitizing. This is a process which is known to be reliable but challenging in terms of being tedious and time consuming (Kraak and Ormeling, 2003). Then, all different features and polygons of different land covers were digitized and saved into their respective classes. This resulted in digital or geo-referenced land use maps for the respective years (See Figure 5).

After artifacts were removed and errors in digitizing were controlled by applying topological model in Arc GIS, various land uses cover for 1984, 2000 and 2016 were extracted and computed. For instance, built up areas were calculated in hectare (ha) using calculate geometry on field area in attribute table in Arc map 10.3. Annual rate of urban area expansion (RUE) for the periods: 1984–2000, 2000–2016 and 1984–2016 was calculated using the following relationship (modified after Mohan et al., 2011):

$$RUA = \frac{UA_{i+n} - UA_i}{n \text{ x } UA_i} \text{ x } 100 \quad \text{..... (1)}$$

where UAi+n and UAi are the urban area in ha at time i+n and i respectively, and n is the interval of the calculating period (in years).

Similarly, the area covered by each LULC class was calculated and subsequently the changes were compared for the periods 1984–2000, 2000–2016 and 1984–2016. The LULC changes were analyzed from two perspectives. The first refers to the changes in LULC as a result of the sprawl of the city, which is hereafter called horizontal expansion. The second refers to changes in LULC that occurred within the 1984 boundary of the city during the period 1984–2016 refer to this type of change as intensification – increasing the density of dwellings and other infrastructures within existing built-up areas (Melia et al., 2011) (Table 1)

To evaluate intensification of built-up areas and to better understand the conversion of Debre Tabor from 1984 to 2016, the 1984 LULC map was used as an AOI to clip and compare with the LULC maps of both 2000 and 2016. The land consumption rate (LCR), which was used as an index to evaluate the progressive spatial expansion of the study area, was determined using the following relationship (Fanan et al., 2011) (Figure 4).

$$LCR = \frac{UA}{P} \quad \text{.....(2)}$$

where UA is area (ha) and P is the population of the town

Projecting the future urban land area is important when analyzing the dynamics and impact of urban expansion. In this study, a currently acceptable approach to project the urban land area as a function of population growth (Lopez et al., 2001; Sutton et al., 2001; He et al., 2008) was adopted. A regression model was established between the town's population and urban area for the years 1984, 1994, 2007 and 2015. Population statistics for the years 1984, 1994, and 2007 were obtained from the Ethiopian Population and Housing Census results. Population data of the study area from 2007 and on wards were projected using the following exponential growth rate relationship recommended by the Ethiopian Central Statistical Agency:

$$P_t = P_o e^{r \text{ x } t} \quad \text{..... (3)}$$

where P_t is the population projected at a given time, Po is the population size of a base year, e is the natural logarithm base, r is annual population growth rate (4.6% for urban areas as previously discussed), and t is the time interval between the base year and the projected year (Figure 2)

Results and Discussion

This research has taken in to account various variables like population growth, urban boundary expansion, changes in LULC within the urban boundary using time series data for three years; 1984, 2000, and 2016 to determine the effects of urban expansion on the surrounding land features and the future expansion of Debre Tabor Town.

Population growth analysis

The first census (1984) result showed that there was a total population of 15,226 people in the town. Later in 1994, total population reached 22,455. The population of the town was 55,596 in the latest national census, in 2007. According to Equation (3), projected population number of the town for the year 2010, 2013, 2016, and 2024 was 63,819, 73,276, 84,108, and 121,512 respectively (Figure 2)

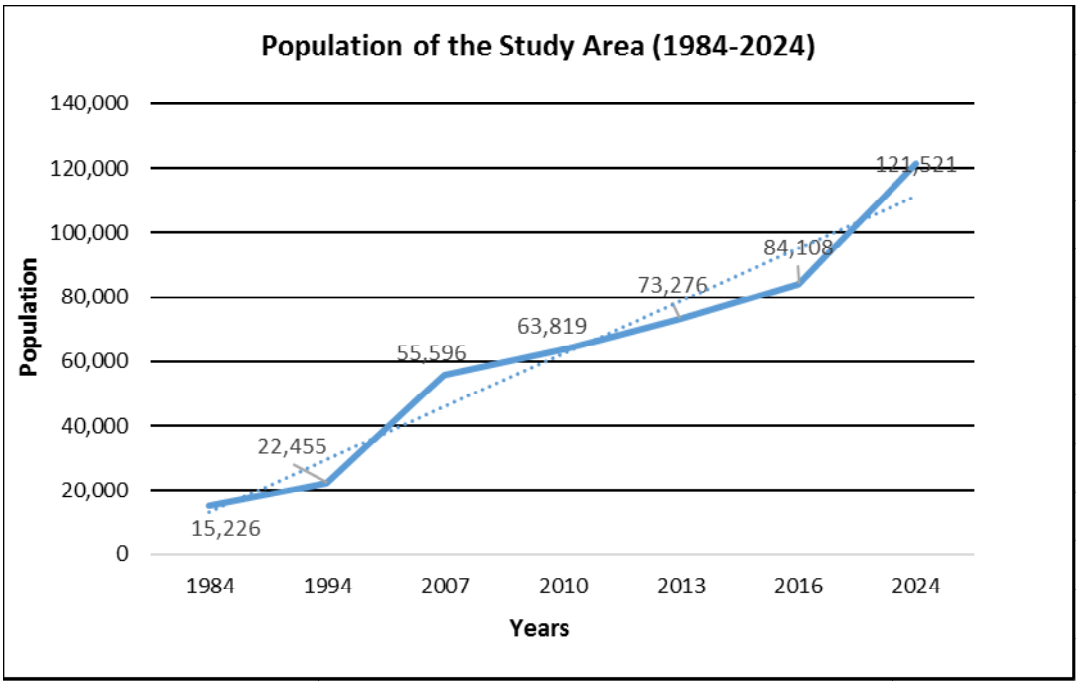


Figure 2. Population trend of Debre Tabor Town (1984-2024)

Therefore, the population of the town grew by 7,229 between the first two successive censuses, and as the projection result revealed there were almost 3,000 additional people every year in the town. Generally, the three census results indicated that there is high population growth in the town. Especially, the population grew more than double in 2007. This is may be due to relatively better provision of job opportunity, facilities and services than other surrounding rural areas or towns in the Zone in particular and better life in general.

It is the fact that urban structure such as built up areas, roads, electric service, telecommunication lines, water and other facilities also increase as population number and associated demand raise. This reality was reflected during Interview (2016), as Land Provision and Administration Heads argued that high demand for house settlement and increase in squatter settlement are due to high population growth. Limited human power resources and equipment's including vehicle were some of the constraints that hamper regular follow up and supervision related to the aforementioned events in the town. This in turn created high challenge to implement effective land use and management system particularly, new master plan in the town.

The present annual growth rate of population varies from rural to urban areas in Ethiopia. According to (ANRS, 2002), the present annual rural growth rate is estimated at 2.8 percent and the population will double in 32 years. Where as in urban areas, growth rate of increase is 4.55 percent per annum, and will double in 17 years. Hence, the population of the study area will double in 2024 and it will be 121,521 since the last national census (2007). As a result, more roads, built up areas and, other facilities and infrastructures will also increase in the town as population numbers rise. So, more effective land use system is also important to balance growing land demand and existing land resources in the study area.

Urban boundary expansion

The urban boundary of Debre Tabor Town has shown remarkable change from time to time. This change was examined using the annual rate of urban area expansion (RUE) in Equation (1). In the year 1984, the total urban area of the town was

205.25 ha. By the year 2000, it had increased by over 459.37 km^2 (69.06%) to 664.62 ha. However, in the next sixteen years, a decline in the expansion rate of the urban boundary was observed as it increased by just over 178.38 ha (18.86%) to a coverage area of 943 ha (Figure 3). The overall boundary change showed in the study area was 738 ha (81.4%), Table 1. The urban boundary of Debre Tabor was found to have expanded under the study periods. However, it shows variation among years. The expansion rate between the years 1984 and 2000 was 69.06%, higher than the rate experienced thereafter to the year 2016 (18.86%).

However, for the last thirty-two years, between 1984 and 2016, the overall boundary increasement of almost eighty one percent (81.4%) was very magnificent. This could be an indication that was the period where the maximum urban development within the town exhibited. The pattern of the boundary expansion has remained constant in all three years in the Eastern and South eastern part of the town due to topographic factor. Mount Eyesus which is stretched in Eastern and South Eastern direction of the town is the main reason that hamper urban growth and expansion. Urban growth seemed to more prevalent in North, and North Western direction in the latter two years; 2000 and 2016 (Figure 3), due to relatively flat terrain.

Land use land cover analysis (1984 – 2016)

The key features that were digitized for LULC maps of the three respective years (1984, 2000 and 2106) included primary roads, and secondary roads, and local roads shown in Table 2. For all three years, features that prominently observed including built up areas, Crop lands, Open lands, and Forests were digitized, but other features that were identified as fragmented huts and hamlet here and there were not taken in to account. In most cases these settlements were situated at the outskirts of the town, where infrastructural development is not as such concentrated and thus not classified as permanent buildings.

***Road network access** (1984 – 2016)*

The road network facilitates the movement of people and hence strengthen social interaction. Roads connect remote communities with the areas where employment options are more concentrated and services and facilities more readily available (Rodrique and Notteboom, 2013).

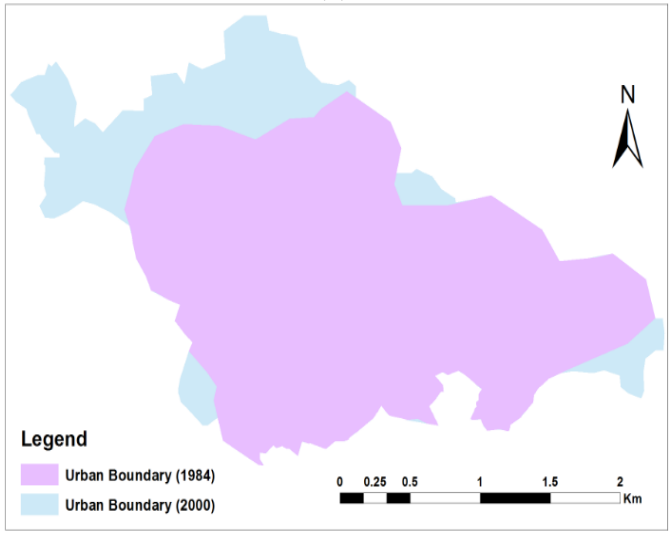
Table 1. Land coverage area of Debre Tabor urban boundary for the years 1984, 2000 and 2016

Year	Urban boundary Area (ha)	Rate of Urban Expansion (RUE)		
		1984-2000	2000-2016	1984-2016
1984	205.1	45		
2000	664.6		3	
2016	943			12
Change ha/year		459	178	738

Table 2. LULC map of Debre Tabor urban area for the years 1984, 2000 and 2016

Feature/LULC		Years and Percentage Change					
		1984	2000	% Change (2000-1984)	2016	% Change (2016-2000)	% Change (2016-1984)
Road Feature (Km)	Primary Road	3.28	5.1	35.69	10.4	50.96	68.46
	Secondary Road	4.77	16.2	70.56	21.53	24.76	77.84
	Gravel Road	15.51	57.35	72.96	95.88	40.19	83.82
LULC (ha)	Built up	120.92	392.91	+ 69.22	634	+38.03	+80.93
	Agriculture	147	160	+8.84	182	+13.75	+23.81
	Open land	129	57	-55.81	49	-14.04	-65.02
	Forest	122	95	-22.13	78	-17.89	-36.07

(a)



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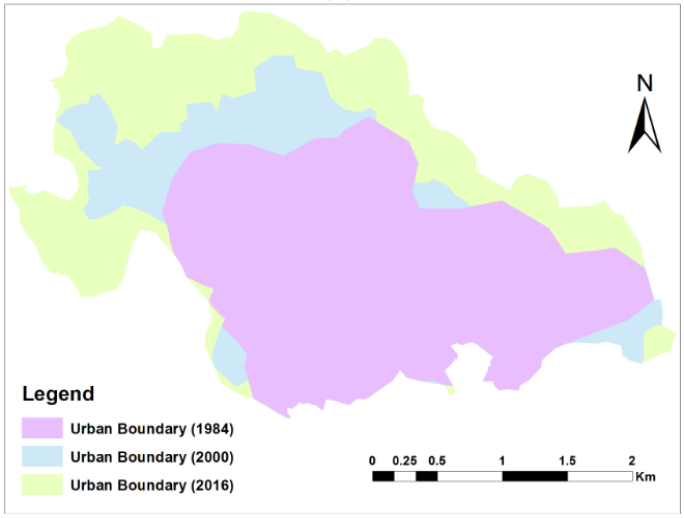


(c)

Figure 3. Urban boundary of Debre Tabor urban area for the years 1984, 2000 and 2016. a) Urban Boundary (1984), b) Urban Boundary (2000) and c) Urban Boundary (2016)

Table 3. Road classes used in the study and their operational definitions (1984-2016)

Classes of Roads	Definitions
Primary road	paved road that provide for major traffic movement between centers of population and economic activity on a national and regional level, wider and high quality in standard.
Secondary road	paved provide access to properties and through routes within a residential area, and relatively wider and good quality than gravel road.
Gravel road	unpaved road surfaced with gravel that links every houses, and relatively narrow and lower quality than others

The analysis result showed that the total primary road length of the town in 1984 was 3.28 km. The road length has increased in to 5.1 km and showed an expansion change by 35.69% (1.82 km) in 2000. Later in 2016, primary road also increased by 5.3 km and reached 10.4 km with 50.96% change. Massive expansion of secondary and gravel road was observed in 1984 and 2000 with an increment change of 70.56% and 72.96% respectively (Table 2). As compared to the first two years (1984, and 2000), the road expansion of the town was very highest in 2016. In this year, there was 21.53 km and 95.88 km secondary and gravel roads consecutively with additional road length of 5 km and 19 km that of 2000. As a whole, the percent change of road expansion in the town between 1986 and 2016 for primary road, secondary and gravel road was 68.46%, 77.84%, and 83.82% respectively. Huge road network expansion was seen in the North, North-West, South and South-West part of the town during 2016 (see Figure 5).

Generally, all road types increased during the study periods. But as compared from other roads, primary roads are not expanded more as expected than others. It seems that such type of road is very expensive so that its expansion is not as secondary and gravel roads due financial constraints of the municipality of the town (Interview, 2016). As experts also explained in the Interview (2016), secondary and gravel roads that connect each household also showed remarkable growth. High land residential distribution under the study periods were attributed to the remarkable growth of secondary and gravel roads in line with the expansion of urban boundary of the town.

The majority of road pattern of the town seems organic pattern. Organic pattern of road is observed in spontaneously formed & developed cities and because of topographic constraints in which pattern of roads are winding forming acute curves & odd junctions. This kind of pattern fits with difficult topographic conditions that oblige the road network to follow an organic pattern (MWUD, 2006). Furthermore, this condition was more demonstrated by Interview (2016). The experts expressed that road types in the town were dominated by organic pattern than others due to the nature of landscape. Hence, such condition allowed only one type of road to be prevailed, and affected urban growth especially, balance and fair road distribution and expansion in the town.

Built up areas, agriculture land, open land and forest land analysis (1984 – 2016)

The main LULC, beside roads, considered under the study periods (1984, 2000 and 2016) were built up areas, agriculture land, open land and forest land. Built up land in the study area has increased substantially during the study years. It occupied 120.92 ha of land in 1984 and increased to 392.91 ha sixteen years later in 2000, with an increase expansion change (69.22%) in these years. In 1984, the agricultural land covered a total of 147 hectares of land, gradually it was raised to 160 hectares in 2000 with an additional of 13 hectares. On the other hand, open lands and forest land also showed remarkable variation between 1984 and 2000. Open land occupied 129 ha in 1984, and through time reduced to 57 ha in the year 2000.

As it shown in Table 2 the percentage change agriculture land and open land was 8.84% and 55.81% respectively in 2000. While forest land constituted 122 ha in 1984 and 95 ha in 2000 with percentage change of 22.13%. The result also indicates that in the year 2016, the area covered by built-up land continued to increase by 38% (634 ha) and agricultural land continued to increase by 13.75% (22 ha). The slight increase observed in agricultural land in various years, 2000 and 2016, were as a result of continued urban boundary expansion into agricultural area. This highlights that, as urban boundary increases, more agricultural lands are incorporated in to urban zone, and gradually altered in to built-up areas as other land features like forests and open lands did. However, the area covered by forest and open land decreased by 18% (78 ha) and 14% (49 ha) respectively in 2016.

Table 4. Land use land cover classes used and their operational definitions (1984-2016)

Classes	Definitions
Agricultural land	all ecosystems modified or created by man specifically to grow or raise various crops for human consumption or use
Built up land	comprises residential, industrial and commercial land cover in urban area
Forest	part of land covered with trees, bushes, and or vegetation density that have not been yet developed for other uses
Open land	embraces of all rocky areas, cleared lands, and vacant spaces with little or no grass cover

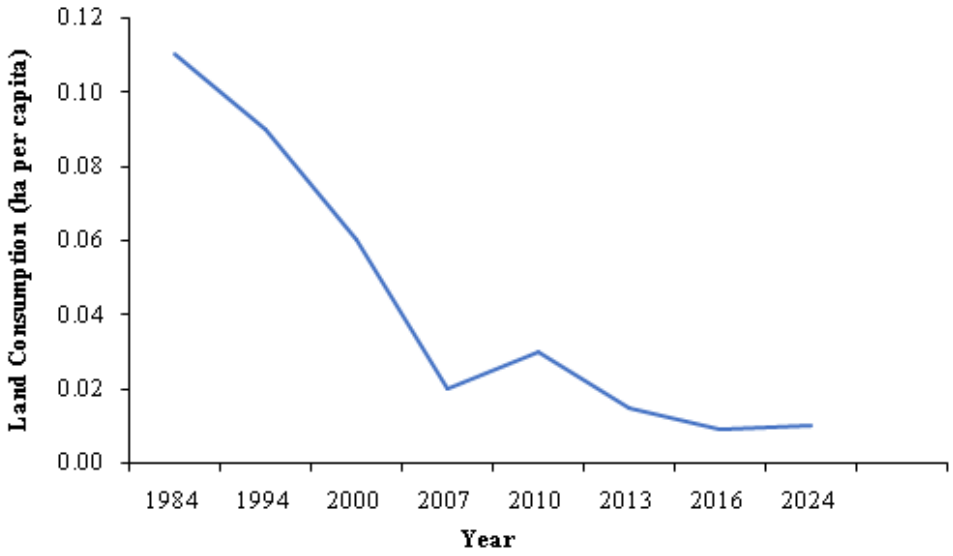
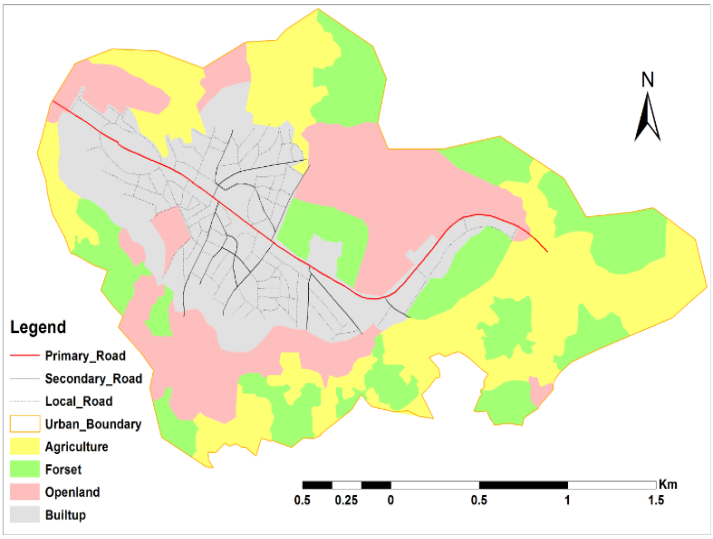


Figure 4. Trend of land consumption per capita from 1984 to 2024 Debre Tabor Town

For the periods covered by the study (1984-2016), the area showed great land-use changes, 23.81% of agricultural land was converted to other uses, the built-up area increased by 80.9% while forest land decreased by 36.1%. The progressive reduction of forests coverage in size seems the increased deforestation mainly for charcoal purpose, uncontrolled grazing in the forest area and encroachment of people for farming, residential and commercial purposes. During these periods, the area covered by open land and forest also decreased by 65% and 36% respectively. This indicated that the demand for land in the area has increased, resulting into conversion of open land, forest and agricultural mainly for settlement uses and for non-extensive agricultural purposes. Furthermore, huge built up area expansion over the expense of agricultural land, forest land and open land was observed in 2016 as compare to 1984 and 2000 (see Figure 5). The increase in built-up land area coverage is attributed to the further increase of population that continues to raise the demand for residential development and other amenities. Thus, Debre Tabor Town has experienced massive expansion from time to time during the study periods as its population exceeds over. This may be attributed by establishment of higher institutions like college, university, factory and other infrastructures in the town. Furthermore, being the center of South Gondar Zone Administration has also its own contribution for the expansion of the town (FGD, 2016).

Urban or residential development appears to have been taking place in different directions in the study periods at the cost of agricultural lands and other land resources. To examine the expansion direction of the town, the built-up areas of three periods were mapped and overlaid using GIS software. Particularly, the North, South, North-West, South-West, and South-East parts of the town are relatively less sloppy areas so that high built-up areas were intensified during the study periods (Figure 5).



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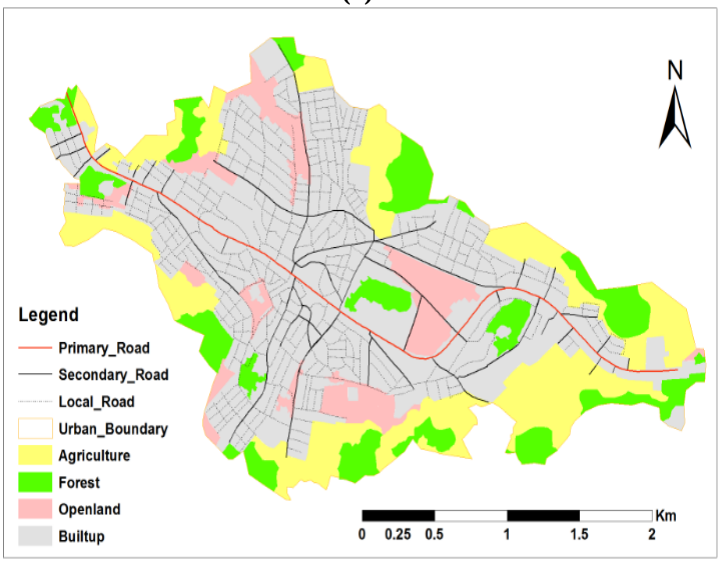

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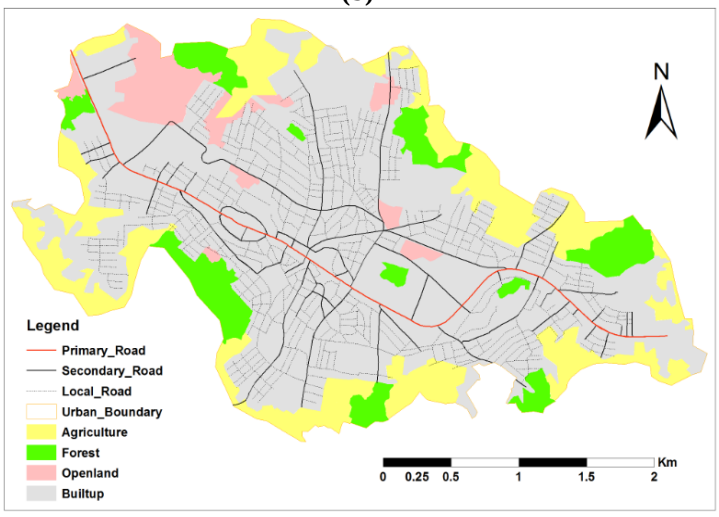

(c)

Figure 5. LULC Map of Debre Tabor urban area for the area 1984, 2000 and 2016 respectively. a) Land use land cover (1984), b) Land use land cover (2000) and c) Land use land cover (2016)

The situation of urban expansion was more emphasized by Interview of Team Experts and FGD (2016), and they claimed that urban expansion especially squatter settlement has affected land resource predominantly agricultural land in the study area. Land consumption per capita for the years 1984, 1994, and 2007, which generally decreased from 0.11 in 1984 to 0.02 in 2007 (Figure 4). This is because of the ever-increasing demand of more urban land for various purposes. For instance, built up area and roads of various types increased and expanded as more land is consumed due to residential and infrastructural developments. This can be witnessed by the information obtained from Focus Group Discussion (2016). The town has experienced the development of various social services such as education of different levels including kindergartens, elementary and secondary schools, and colleges and university, and health institutions like health centers and hospital, other facilities and amenities. The per capita land consumption estimates obtained in this study are within the range (0.004–0.125 ha) reported by Demographia World Urban Areas (2010) based on population data from 1400 towns and cities from different parts of world.

Future expansion of the town

The world is currently experiencing massive demographic changes through differing rates of natural increase and net migration (Cohen and Goward, 2004). In the early 21st century, cities generated over half of global GDP and this economic dominance is helping drive their continued growth (Oxford Economics, 2015). In 2014, 28 megacities were home to 453 million people; by 2030, 13 new megacities are expected to emerge in the less developed regions (UN, 2014). Most of the urban growth is expected to take place in small and medium sized cities where urbanization is occurring faster and at larger volumes in locations that are at lower stages of economic development and face rapid demographic changes (Montgomery, 2008 and Angel et al., 2005). Thus, forecasting future urban expansion in terms of population is very important to use and manage the existing limited land recourses effectively.

A regression model was established to see the relationship between the town's population and urban area for the years 1984-2024. The result shows that total population and total urban area have the following linear relationship between the two (UA = 0.024 +580, (R^2 = 0.98; < 0.05).

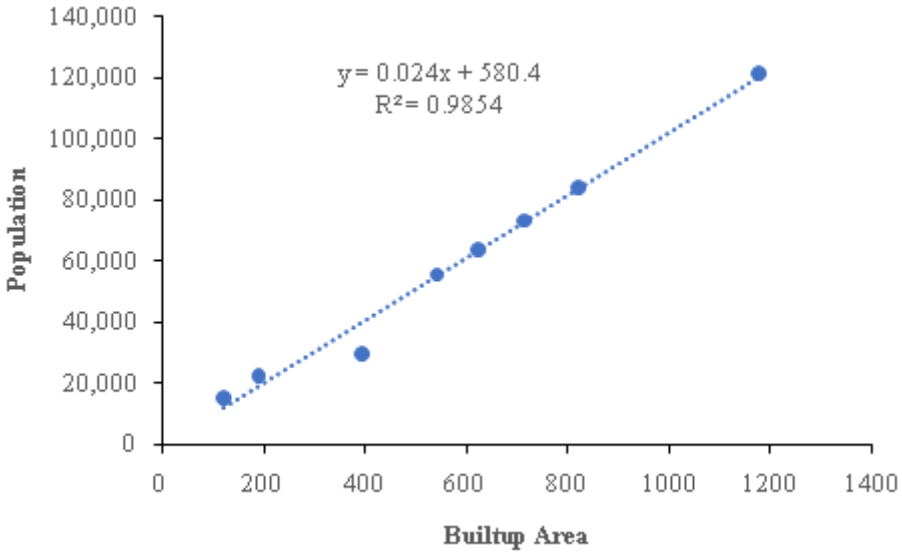

Figure 6. Relationship between population and urban built-up area

As depicted in (Figure 6), the investigation relationship between population and urban areas showed also good correlation (R^2 = 0.95). Moreover, urban area and population showed correction with R^2 of over 0.99. Depending on this situation, future demands for urban areas in the study area was forecasted with an estimated result in an increase of 6.5%. The result indicated that in 2024, 1,174 ha of new lands for urban area would be demanded by the growing population of Debre

Tabor Town. Therefore, by 2024, an additional 1,174 ha of urban areas will be needed to hospitalize 121, 512 new residents in the town.

Moreover, as it was reveled in Equation (1), and Equation (3) relationship between populations and urban areas was assessed, future population and future land demands for urban expansion were forecasted for 2024. Hence, the urban area will have expanded due to urban sprawl. This tends to may cause continuous loss of agricultural lands in the future. To prevent loss of fertile lands against ongoing expansion of urban areas, effective land use and land management is strongly advocated.

Conclusion

The main objective of the study was to examine the effects of urban expansion on land uses proximity to urban areas around Debre Tabor, Northwestern Ethiopia. The study of urban expansion and its implications on land use/cover change is of much benefit to citizens as well as planners and policy makers as it provides an insight into the significant factors and effects determining land use change. This will to help identify problems in terms of increasing residential land use at the expense of agricultural land and provide the platform for better management of land resources in the nearby urban area. Urban growth and development change agricultural land use to residential land use in close to urban area. Such changes have had negative effects on agricultural land use. With increased high demand for land for construction of both commercial and residential developments including infrastructure such as road networks, more land-use and land cover changes are likely to take place as more land is converted over time, forest to agricultural land, and agricultural land to built-up land, which threatens the existence of agricultural land and water sources in the future. Efficient tools such as satellite remote sensing and Geographic Information System (GIS) are currently being used to assess urban growth. The integration of remote sensing and GIS in urban planning provides a powerful tool for assessing, monitoring and making future projections on urban growth, effects on various land uses/covers. As witnessed in the study area through remote sensing products and interviews as well as observations, it is possible to conclude that urban sprawl has resulted to increased pressure on the natural land. In addition, urban sprawl has negatively impacted agricultural land resulting to conflict of interest in land uses between agricultural uses and built up urban uses. In conclusion, urban expansion is inevitable in the course of urban growth. Current trends of land-use land cover change continue, if mechanisms are not put in place to control development. Hence the need to investigate and gain an in-depth knowledge on the trend of land use/cover change as an assessment of urban expansion in the near-urban area utilizing remote sensing and GIS techniques is worthy. Hence, it is advisable if the conceded bodies use these technologies on going urban development.

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